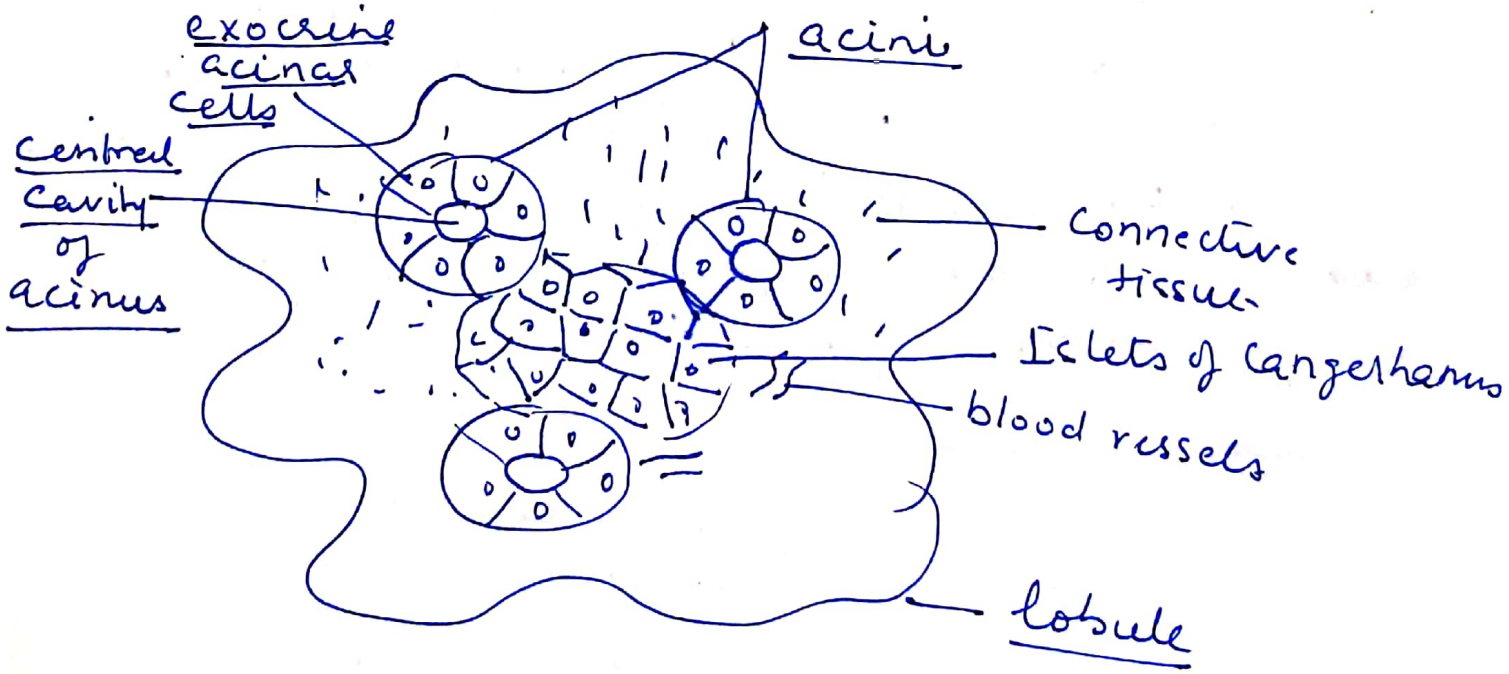
Pancreas (Digestive Gland). (1)

Pancreas is the second largest digestive gland in the body of the animals. It is a heterocrine gland of irregular shape containing two types of tissues — the exocrine tissue and the endocrine tissue both having separate functions:

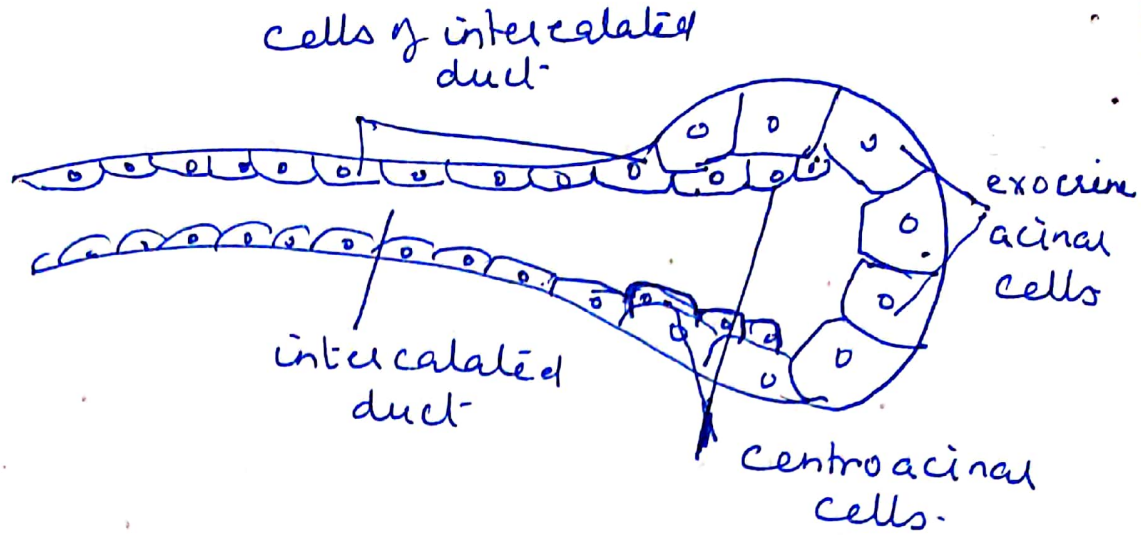
(a) Exocrine tissue: It forms the main mass of the gland. It contains numerous lobules, each made up of a group of small, rounded sacs called alveoli or acini. The lobules and their acini are held together by connective tissue. The lobules contain blood vessels, lymph vessels, ductules and nerves. Each alveolus or acinus has a narrow central cavity enclosed by a single layer of large, pyramidal glandular cells called exocrine acinar cells with prominent nuclei. These cells secrete enzymes of the pancreatic juice into the narrow central cavity that leads into small intercalated duct that is lined by epithelial cells. These intercalated ducts join together to form larger intralobular ducts which finally join the main pancreatic duct which leads into the duodenum directly or indirectly. In addition to the exocrine acinar cells acini are also composed of centro acinar cells. These cells centrally located within the acinus. These cells are actually the extensions of intercalated duct cells (epithelial cells lining the intercalated duct) into the acinus. These cells produce bicarbonates which enter into the intercalated duct & then to the intralobular ducts & then to the pancreatic duct and ultimately to the duodenum.

The exocrine acinar cells secrete pancreatic juice. The secretion of pancreatic juice is stimulated by the harmone cholecystokinin produced by the I-cells of the duodenal epithelium and is carried to the pancreas by the blood. The harmone is produced in response to the

acidic chyme ie when the acidic chyme from the stomach comes in contact with the duodenal epithelium. The centroacinar cells produce bicarbonate under the influence of the harmone secretin produced by the duodenal epithelium ie the S-cells of the duodenal epithelium and is carried to the pancreas by blood. These bicarbonates serve to neutralize the acid from the stomach. The HCl secreted by the stomach can be damaging to the intestinal lining therefore it is promptly diluted and neutralized by the secretin through the production of bicarbonates [Secretin also inhibits the secretion of gastrin harmone thus inhibiting the secretion of HCl and delaying gastric emptying]. When the acidic chyme from the stomach is fully neutralized the secretion of secretin and cholecystokinin stops because both of them are released when acidic chyme comes in contact with duodenal epithelium



T.S of mammalian pancreas, a single lobule.



Single acinus showing exocrine acinal cells, centroacinal cells intercalated duct and the cells of the intercalated duct in mammals

Pancreatic juice is strongly alkaline and consists of.

(i) Trypsinogen - It is activated to Trypsin by enterokinase present in the intestinal juice. Once Trypsin is formed, it helps to continue activation of additional trypsinogen into trypsin Trypsin breaks proteins such as albumens and collagen into peptides.

(ii) Chymotrypsinogen: It is activated to enzyme chymotrypsin by trypsin. It splits proteoses and peptones into peptides.

(iii) Procarboxypeptidase - It is activated to enzyme carboxypeptidase by trypsin. It converts peptides into dipeptides and amino acids.

(iv) Pancreatic amylase: It converts starch, glycogen and dextrin into double sugars - maltose, isomalto and "limit" dextrin resp.

(v) Pancreatic lipase: It breaks fats into fatty acids and glycerol.

Nucleases: (Ribonucleases and Deoxyribonucleases): They break RNA + DNA respectively into their constituent nucleotides

Endocrine tissue: The endocrine tissue of the pancreas consists of compact masses of small cells called islets of Langerhans, scattered in the connective tissue in the lobules. These islets have two types of cells that produce different types of harmones: Beta cells secrete insulin and alpha cells produce glucagon The harmones pass directly into the blood vessels and control the level of sugar in blood.

Pancreas in different vertebrates

Cyclostomes: There is no pancreas in adult lamprey. The submucosa of the anterior part of the intestine contains 2 types of secretory cells – zymogen cells + islets of langerhans. The zymogen cells produce enzymes which are tryptic in nature ie which cause the break down of proteins and thus represent the exocrine part of pancreas. The secretions of the follicles of langerhans control the blood glucose level. These cells are thus homologus with the endocrine part of the pancreas.

Fishes: Elasmobranchs eg. Scoliodon has a compact bilobed pancreas with dorsal and ventral lobes. The dorsal lobe runs parallel to the posterior part of the cardiac stomach and a small ventral lobe is closely applied to the pyloric stomach. The small pancreatic duct passes through the entire length of the gland to open into the intestine just opposite to the opening of bile duct.

Many teleosts and lung fishes do not have a well defined pancreas. In case of Labeo (Teleost), Pancreas is rather diffused, found scattered in liver, spleen and fat of intestinal mesentery. Fine tubules arise from the pancreatic tissues and ultimately unite to form the pancreatic duct. It then opens into the intestinal bulb (upper part of the intestine) along with the bile duct. Both the pancreatic duct and bile duct are enclosed in a common sheath, but in this sheath they remain separated (ie they do not unite to form a common duct).

Amphibians and Reptiles: Both Amphibians and Reptiles have elongated pancreas located between the stomach and the duodenum. In frog and wall lizard. it has many pancreatic ducts which open into the common bile duct where as in Uromastix (a lizard) there is a single pancreatic duct that opens into the duodenum.

Birds - Pancreas is a compact organ situated in the loops of U-shaped duodenum. It sends 3 pancreatic ducts into the distal limb of duodenum.

Mammals: In mammals the pancreas is located in the loops of the duodenum. They generally have two pancreatic ducts: dorsal and ventral. The dorsal duct opens into the duodenum where as the ventral opens into the bile duct. Both the ducts are functional in horse and dog; only ventral is functional in cat, sheep and man and only dorsal duct is functional in pig, Ox and rabbit.

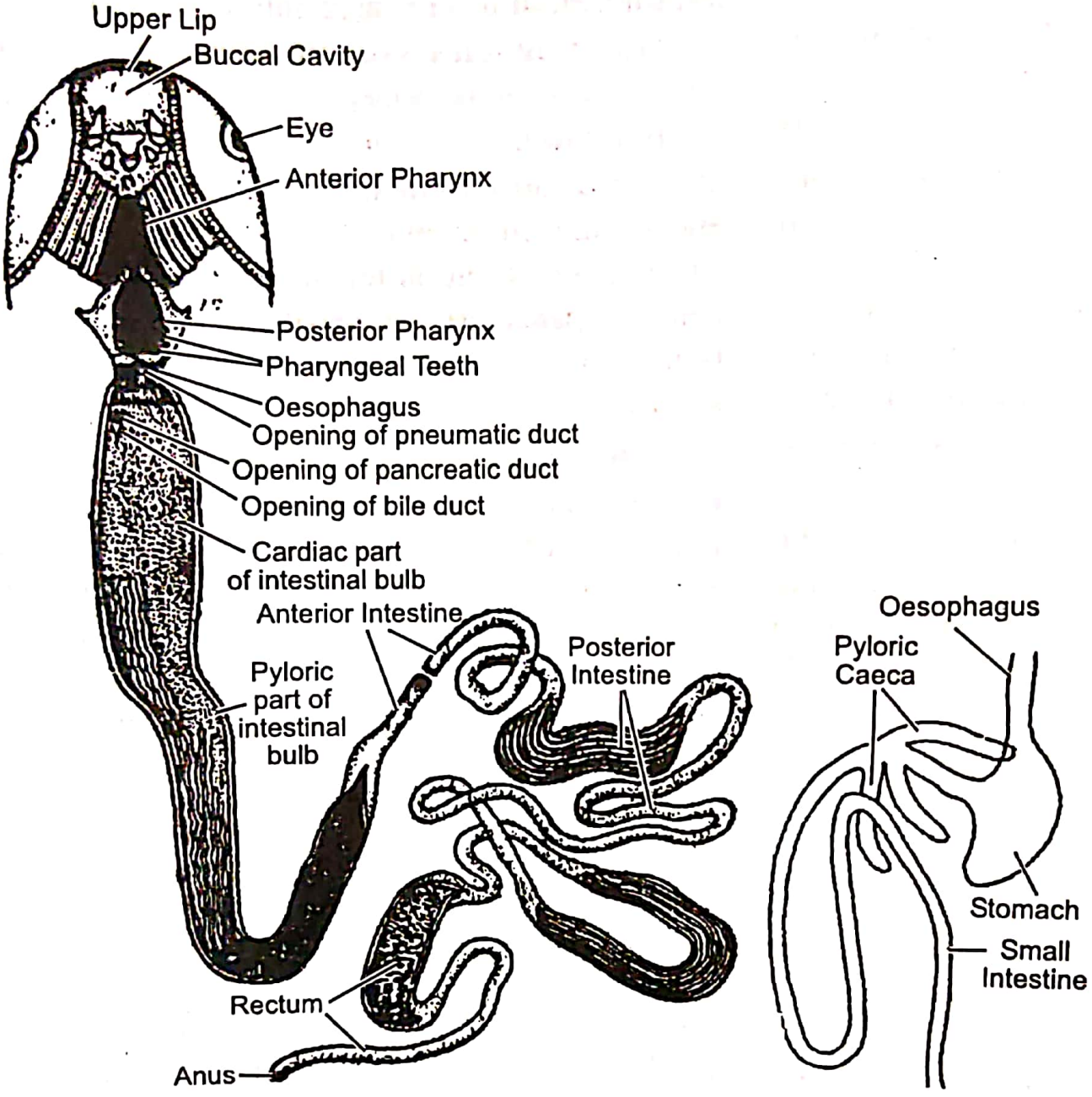


FIGURE 4.26. Alimentary canal of *Labeo* (left) and perch (right).

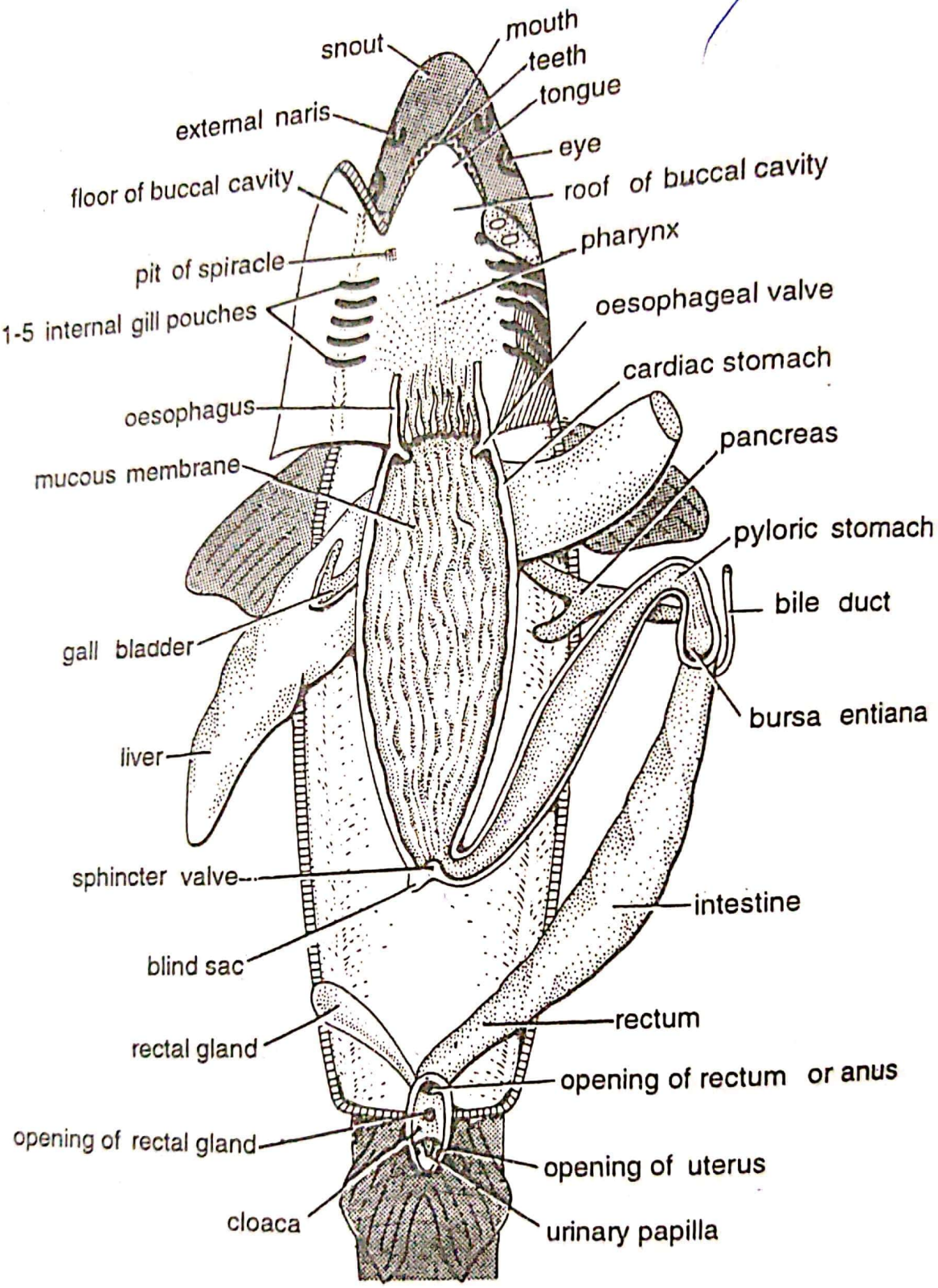


Fig. 10. *Scoliodon*. Dissection of digestive system in ventral view.

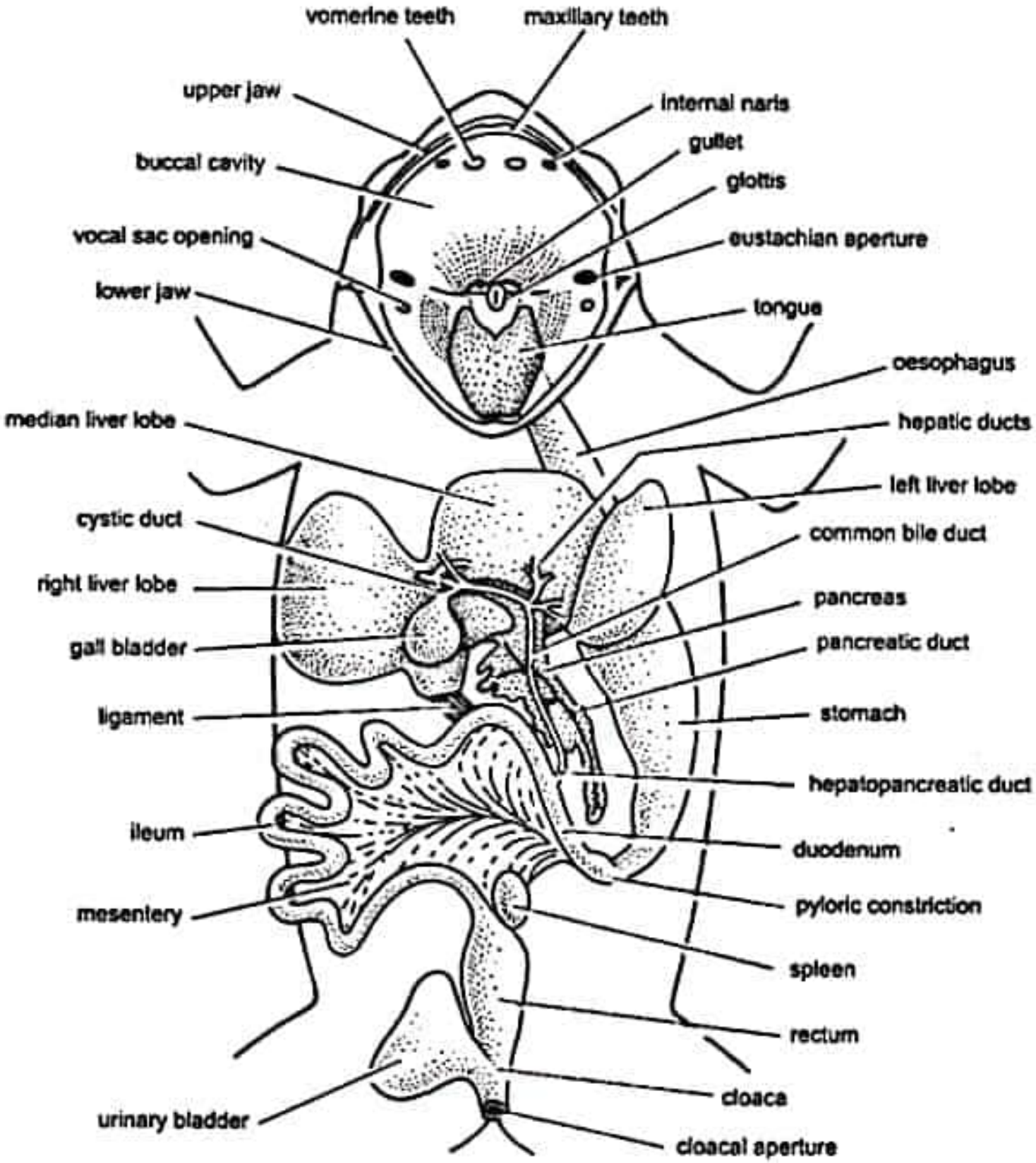


Fig. 18.21. Frog. Digestive system in ventral view.

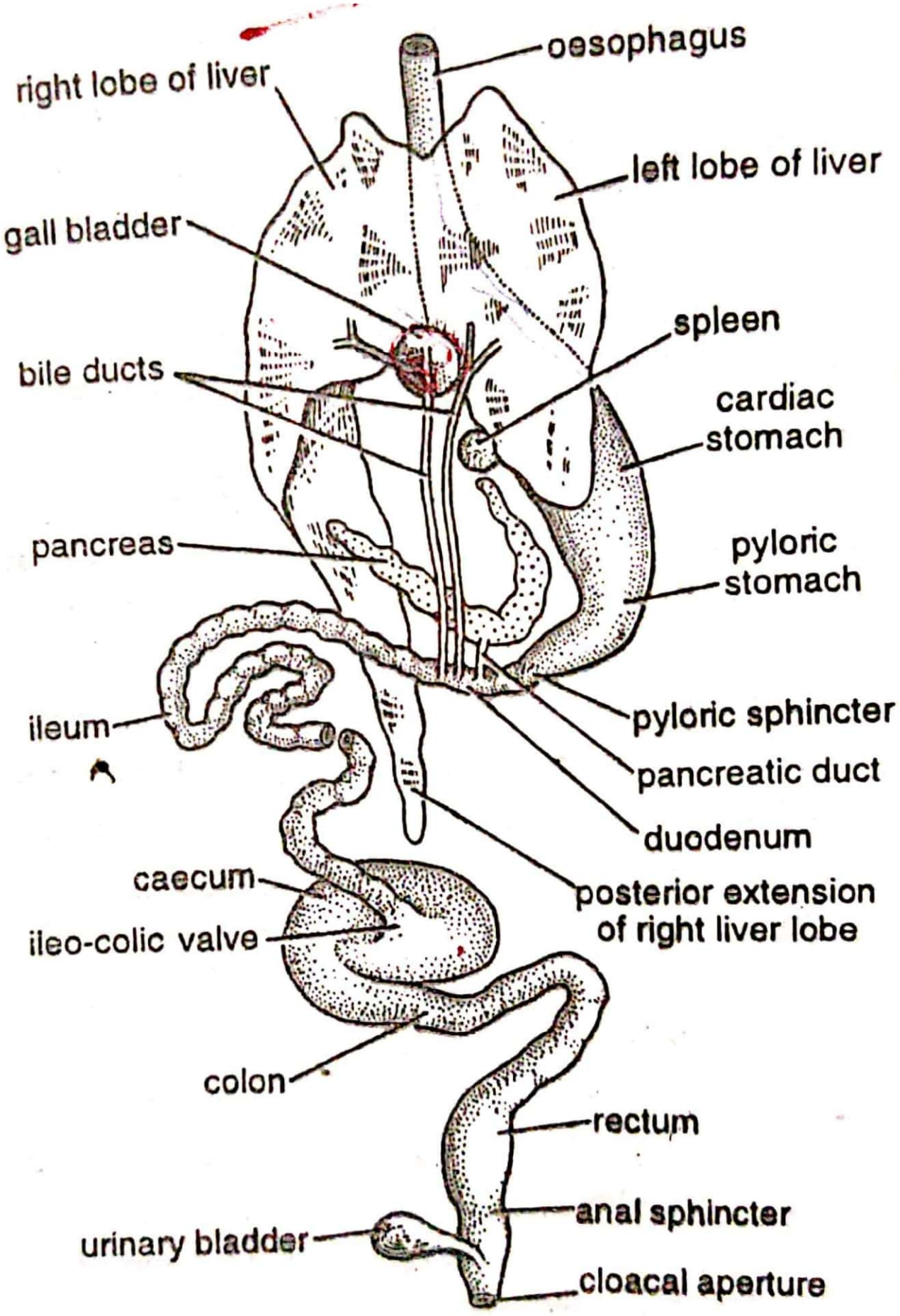


Fig. 4. *Uromastix*. Alimentary canal and digestive glands.

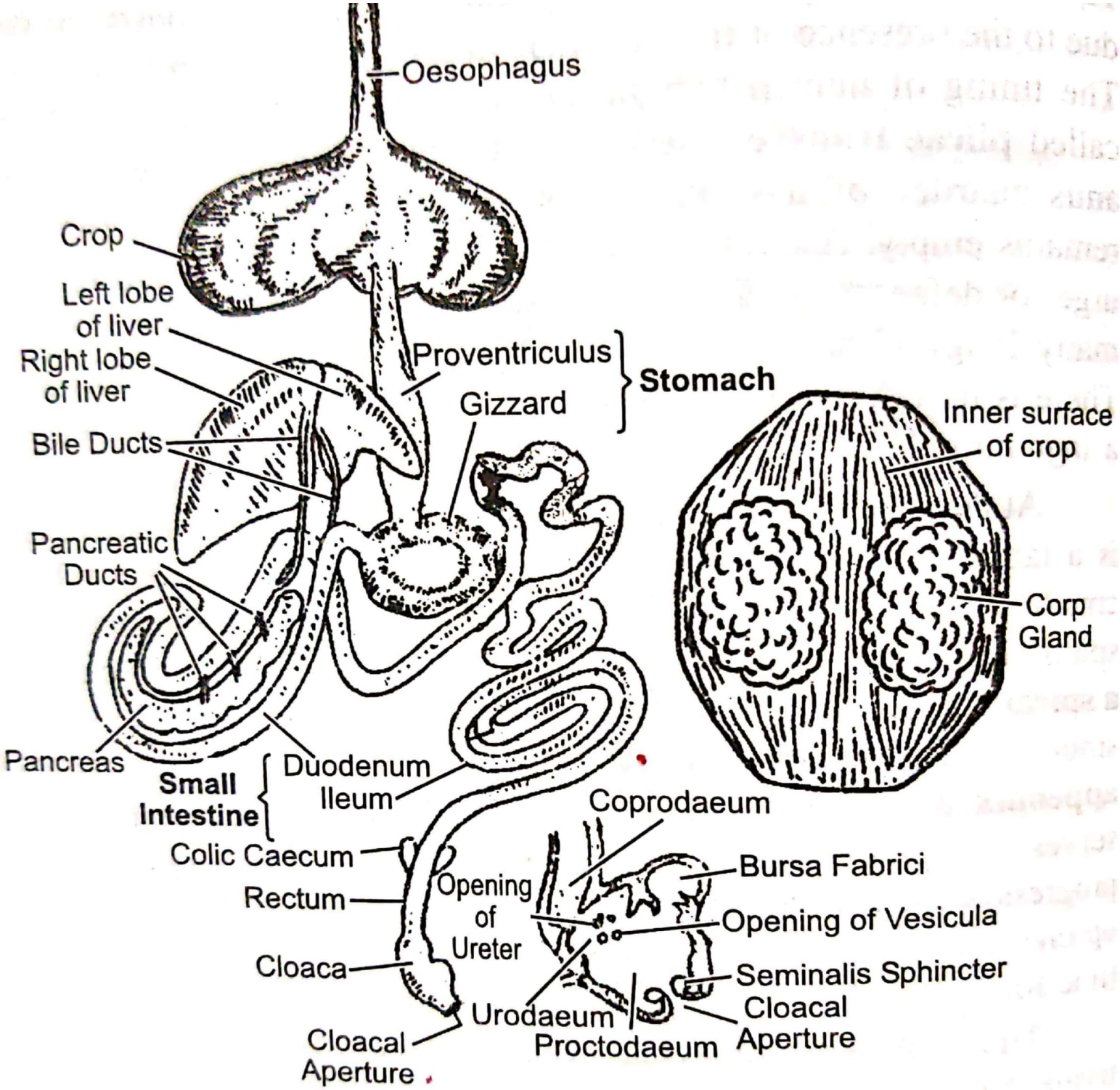


FIGURE 4.30. Alimentary canal and digestive glands. Crop and cloaca (cut open) of pigeon.

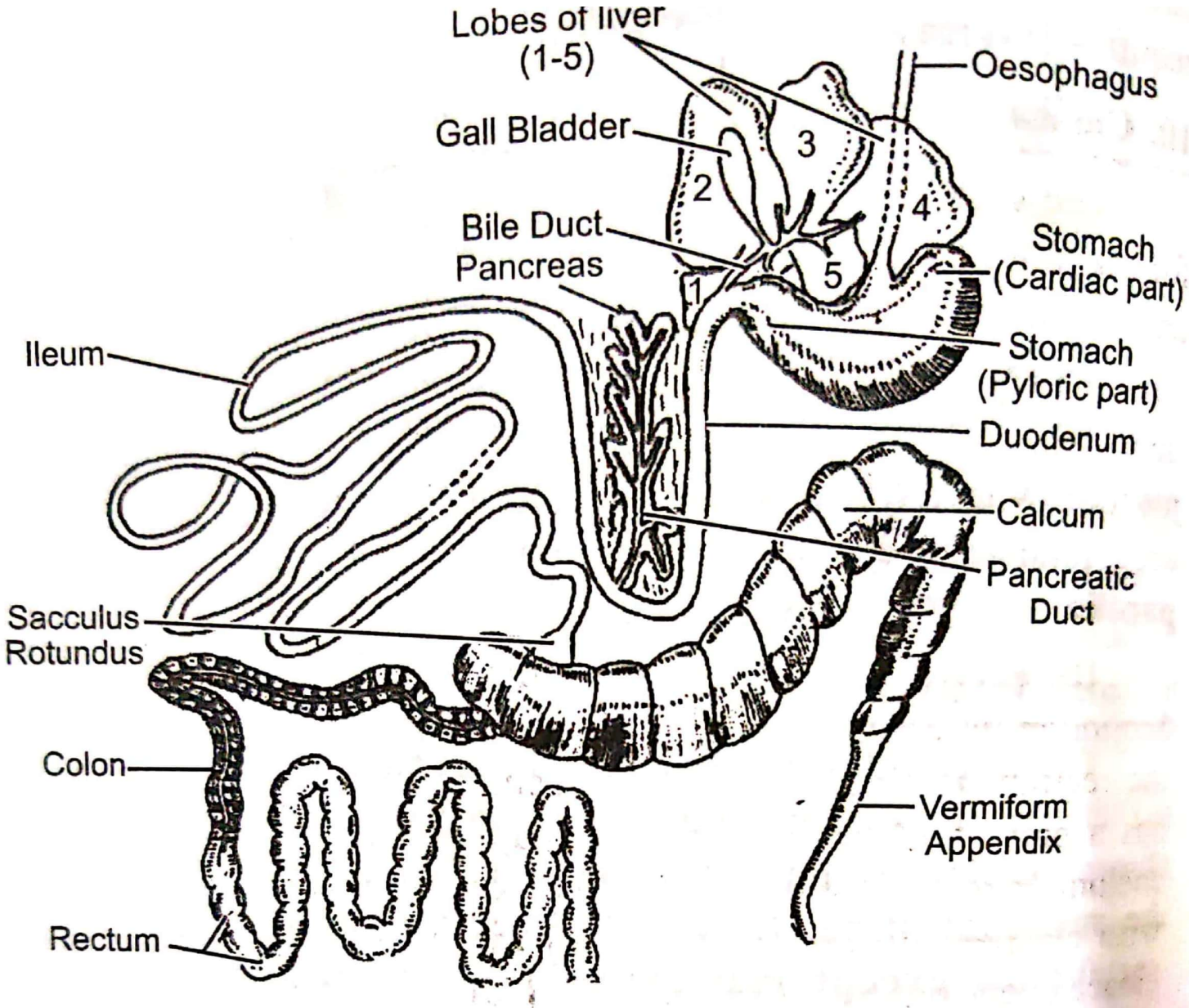


FIGURE 4.31. Alimentary canal and digestive glands of rabbit.